FEMA 29: 125115

FLOOD INSURANCE STUDY

WAVE HEIGHT ANALYSIS

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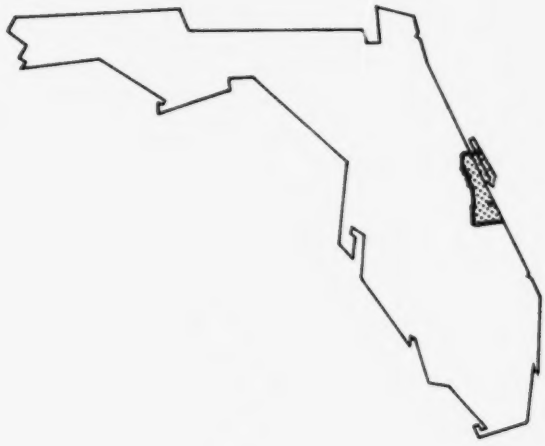
TOWN OF INDIALANTIC, FLORIDA
BREVARD COUNTY



MARCH 30, 1982

Federal Emergency Management Agency

COMMUNITY NUMBER-125115

ANALYSIS OF WAVE HEIGHTS
FOR
TOWN OF INDIALANTIC, BREVARD COUNTY, FLORIDA

FEDERAL EMERGENCY MANAGEMENT AGENCY

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1.0 INTRODUCTION

1.1 Background and Purpose

The Federal Emergency Management Agency recently adopted recommendations by the National Academy of Sciences to include prediction of wave heights in Flood Insurance Studies for coastal communities subject to storm surge flooding, and to report the estimated wave crest elevations as the base flood elevations on Flood Insurance Rate Maps (FIRMs).

Previously, FIRMs were produced showing only the stillwater storm-surge elevations due to the lack of a suitable and generally applicable methodology for estimating the wave crest elevations associated with storm surges. These stillwater elevations were subsequently stipulated in community flood plain management ordinances as the minimum elevation of the first floor of new construction. Communities and individuals had to consider the additional hazards of velocity waters and wave action on an ad hoc basis. Because there has been a pronounced tendency for buildings to be constructed only to meet minimum standards, without consideration of the additional hazard due to wave height, increasing numbers of people could unknowingly be accepting a high degree of flood-related personal and property risk in coastal areas subject to wave action. Therefore, the Federal Emergency Management Agency has pursued the development of a suitable methodology for estimating the wave crest elevations associated with storm surges. The recent development of such a methodology by the National Academy of Sciences (Reference 1) has led to the adoption of wave crest elevations for use as the base flood elevations in coastal communities.

Flooding has been caused by several hurricanes in and around Indialantic. Among the more severe were the storms of July-August 1926 and August-September 1964. The center of the 1926 hurricane entered the coast near Cocoa Beach, Florida, approximately 16 miles south of Indialantic, and passed close to Titusville. Maximum winds of 60 to 70 miles per hour were reported at Titusville. The center of Hurricane Cleo (1964) passed through Brevard County in a north-northwesterly direction almost parallel to the coast.

The Town of Indialantic is located on the open coast of the Atlantic Ocean and is subject to tidal flooding associated with hurricanes. The purpose of this study is to revise the FIRM for the Town of Indialantic to include the effects of wave action associated with flooding from the Atlantic Ocean at the open coast and at Indian River.

2.0 INVESTIGATIONS

2.1 Previous Studies

Stillwater elevations for hurricane surges with 10-, 50-, 100-, and 500-year return periods were determined by the National Oceanic and Atmospheric Administration (NOAA) for the open coast of Brevard County. The 100-year stillwater

elevations were used as base flood elevations on the FIRM that is currently in effect for Indialantic (Reference 2).

The NOAA storm-surge elevations were determined using a computer model of hurricane forces (References 3 and 4). Weather records were analyzed to determine probable atmospheric pressure drop, radius of maximum winds, and forward speed and direction of storms occurring near the study area. Using these data, in conjunction with the astronomic tides and bathymetric data, stillwater elevations for various probabilities were calculated. Results of these calculations were calibrated against tide gage records and high-water marks for historical events at various locations along the coast.

Tidal backwater elevations for Indian River were determined by NOAA using high-water marks from storms and data from available reports by the U.S. Army Corps of Engineers and Brevard County (References 5 and 6).

The stillwater elevations developed by NOAA for the open coast and Indian River were used as the starting water-surface elevations for the wave height analysis presented herein, with the exception of the 10-year surge elevation used for Banana River which was increased based on revised elevations submitted by NOAA in 1977 (Reference 7) and engineering judgment.

This report is authoritative for purposes of the National Flood Insurance Program, and data presented herein supersede all previous flood elevation determinations.

2.2 Data Collection and Review

All available source data applicable for the wave height analysis were collected and reviewed. Because wave height calculations are based on such parameters as the size and density of vegetation, natural barriers (such as sand dunes), buildings, and other manmade structures, it was necessary to obtain detailed information on the physical and cultural features of the study area.

Officials of the Town of Indialantic and Brevard County were contacted for maps and other possible data sources to be used in the analysis. In addition, the Florida Department of Natural Resources, Bureau of Beaches and Shores; the Florida Department of Transportation; the U.S. Army Corps of Engineers, Jacksonville District; and the National Ocean Survey were contacted and all applicable data sources were obtained.

The principal source materials used for the wave height analysis are listed below.

a. Topographic data (ground elevations, seawall elevations, and locations of physical features) were determined using U.S. Geological Survey topographic maps at a scale of 1:24,000, with a contour interval of 5 feet (Reference 8); Florida Department of Natural Resources topographic maps at a scale of 1:1200, with a contour interval of 2 feet (Reference 9); National Ocean Survey storm evacuation maps

at a scale of 1:62,500, with a contour interval of 5 feet (Reference 10); and beach profiles of the immediate Atlantic coast area obtained from the Florida Department of Natural Resources (References 11 and 12).

b. Recent stereoscopic aerial photography at a scale of 1:12,000 was used to determine vegetation parameters and to supplement the topographic maps for locations of physical features in Indialantic (References 13 and 14).

2.3 Wave Height Analysis

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in the National Academy of Sciences report (Reference 1). This method is based on the following major concepts. First, depth-limited waves in shallow water reach a maximum breaking height that is equal to 0.78 times the stillwater depth. The wave crest is 70 percent of the total wave height above the stillwater level. The second major concept is that wave height may be diminished by dissipation of energy due to the presence of obstructions, such as sand dunes, dikes and seawalls, buildings, and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by procedures prescribed in Reference 1. The third major concept is that wave height can be regenerated in open fetch areas due to the transfer of wind energy to the water. This added energy is related to fetch length and depth.

Wave heights were computed along transects (cross section lines) in accordance with the Users Manual for Wave Height Analysis (Reference 15). The transects were located along the coastline as shown in Figure 1. They were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, they were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects.

Each transect was taken perpendicular to the shoreline and extended to the inland limit of tidal flooding. Along each transect, wave heights and elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. The stillwater elevations for the 100-year flood were used as the starting elevations for these computations. Wave heights were calculated to the nearest 0.1 foot, and wave elevations were determined at whole-foot increments along the transects. The location of the 3-foot breaking wave for determining the terminus of the V Zone (area with velocity wave action) was also computed at each transect. Table 1 provides a listing of the transect locations and stillwater elevations.

Figure 2 is a profile for a typical transect illustrating the effects of energy dissipation and regeneration on a wave as it moves inland. This figure

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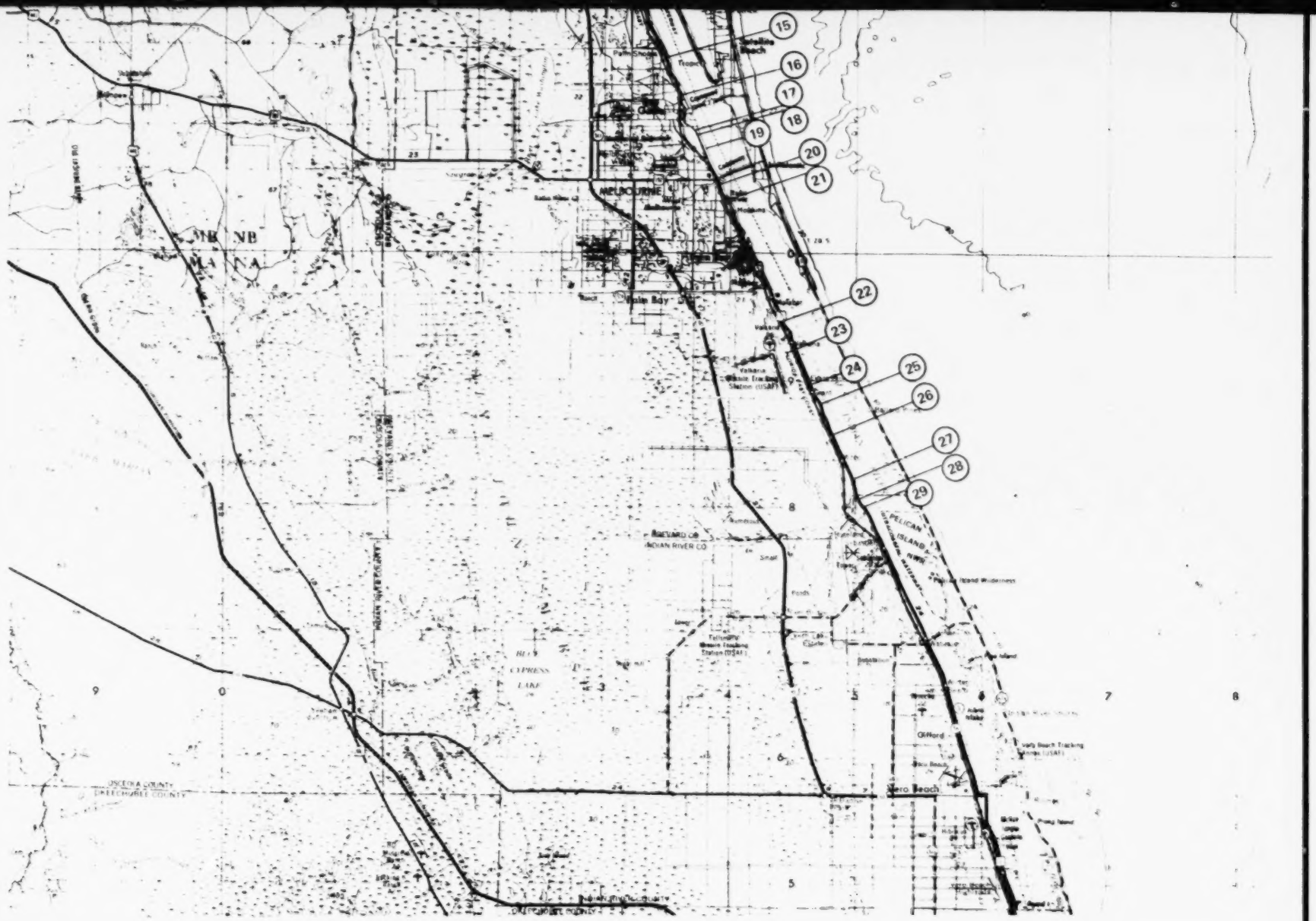
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Fellsmere
Micco
Grant
Malabar
Palm Bay
Valkaria
Melbourne Beach
Indialantic
Melbourne Village
Satellite Beach
Indian Harbour Beach
Cocoa
Rockledge
Cocoa Beach
Merritt Island
Titusville
Scottsmoor
Mims
Oak Hill
Edgewater
Oak Hill
Port Orange
New Smyrna Beach
Daytona Beach
Ormond Beach
Flagler Beach
Palm Coast
Bunnell
Ormond-by-the-Sea
Ponce Inlet
Daytona Beach Shores
South Daytona
Holly Hill
Orange City
Deltona
Debary
Lake Helen
Orange City
Enterprise
Osteen
Geneva
Chuluota
Oviedo
Winter Springs
Casselberry
Longwood
Lake Mary
Sanford
Deltona
Debary

Table 1.
Transect Locations, Stillwater Elevations, and Maximum Wave Crest Elevations

Transect	Location	Elevation (Feet NGVD) Stillwater	Wave Crest
19	Brevard County - From limit of tidal flooding on the eastern side of Indian River westward across Indian River; crosses Shoreview Drive near intersection with South Pacific Drive	6.0	8
20	Indialantic - From Atlantic coastline westward across Indialantic and Indian River; crosses Miramar Avenue (State Highway AlA) just south of intersection with Tenth Avenue	8.3	13
21	Melbourne Beach - From Atlantic coastline westward across Melbourne Beach and Indian River; crosses Oak Street (State Highway AlA) approximately 450 feet north of intersection with Atlantic Street	8.3	13

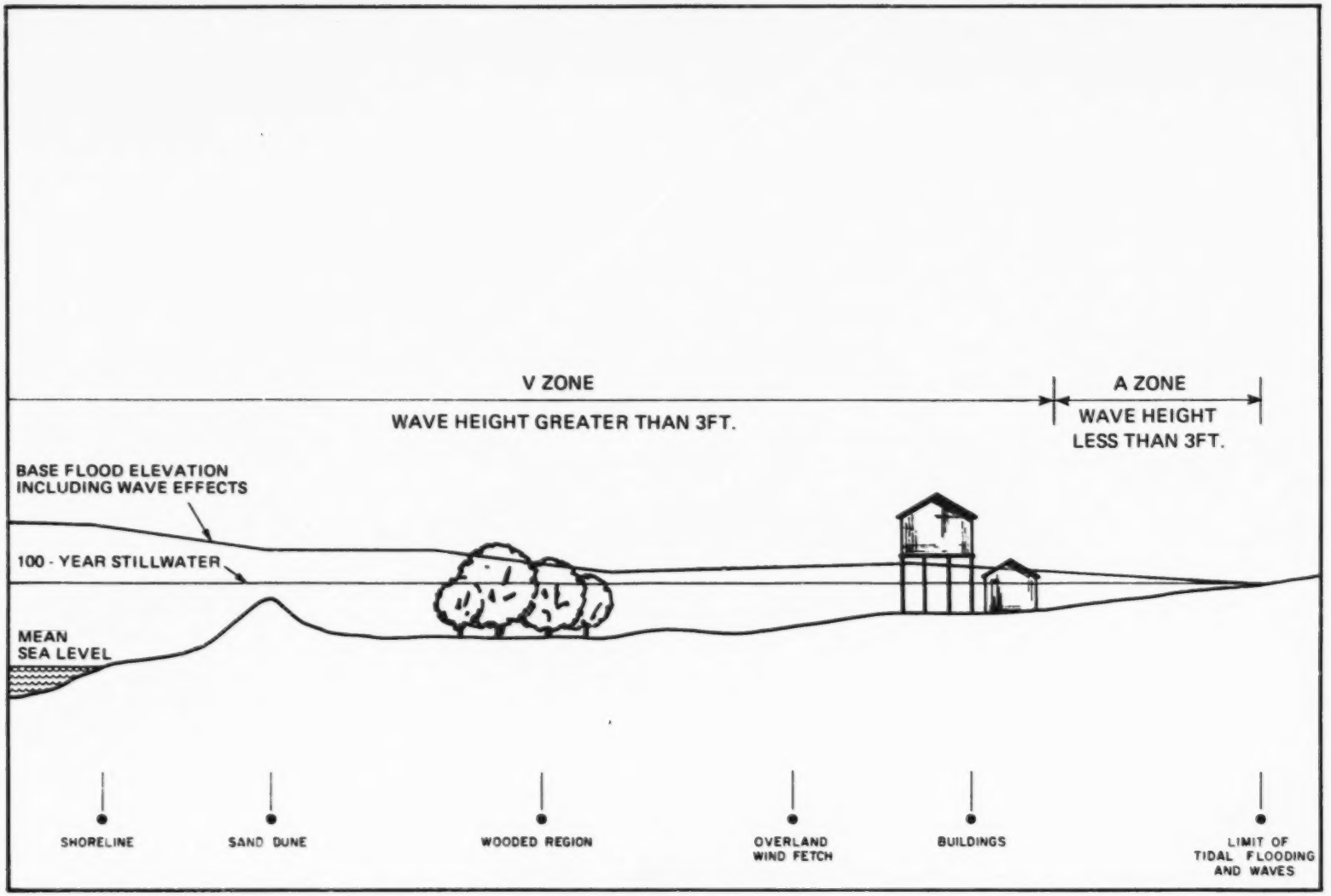

FIGURE 2
TYPICAL TRANSECT SCHEMATIC

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shows the wave elevations being decreased by obstructions, such as buildings, vegetation, and rising ground elevations, and being increased by open, unobstructed wind fetches. Actual wave conditions in Indialantic may not necessarily include all the situations illustrated in Figure 2.

After analyzing wave heights along each transect, wave elevations were interpolated between transects. Various source data were used in the interpolation, including topographic maps (References 8, 9, and 10), beach profiles (References 11 and 12), and aerial photographs (References 13 and 14), along with engineering judgment.

2.4 Results

The U.S. Army Corps of Engineers has completed a beach restoration project along the Atlantic coastline from Third Avenue in Indialantic to Sixth Avenue in Melbourne Beach. The new shoreline is characterized by a foreshore slope rising to an elevation of approximately 10 feet. Behind the foreshore slope is a flat berm, approximately 100 feet wide, which acts against erosion that can occur from waves breaking on the foreshore during a hurricane. Wave heights along the Atlantic coastline, from Third Avenue to the northern corporate limits of Indialantic, were found to be completely dissipated, and the 100-year storm surge of 12 feet is halted by the foreshore slope. At the leeward side of the foreshore slope, several seawalls and vegetated-covered dunes, with elevations of 12 to 20 feet, provide additional protection against storm tides more severe than the 100-year surge.

Wave heights of up to approximately 2 feet are generated across the portion of Indian River in Indialantic.

3.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

A prime purpose of the National Flood Insurance Program is to encourage local governments to adopt sound flood plain management programs designed to reduce future flood losses. The FIRM for Indialantic has been revised to incorporate the latest available information, including wave height data, to assist these communities in developing the most appropriate and effective flood plain management measures.

3.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the Federal Emergency Management Agency as the base flood for purposes of flood plain management. This flood has a 1 percent chance of being equalled or exceeded each year and is expected to be exceeded once on the average during any 100-year period. The risk of having a flood of this magnitude or greater increases when periods longer than 1 year are considered. For example, over a 30-year period, there is a 26 percent chance of experiencing a flood equal to or greater than the 100-year flood. The 500-year flood plain is also shown on the FIRM to indicate areas of moderate flood hazards.

Areas inundated by the 100-year flood are shown as A and V Zones on the community's FIRM. It is in these areas that the Federal Emergency Management Agency requires local communities to exercise flood plain management measures as a condition for participation in the National Flood Insurance Program.

3.2 Base Flood Elevations

Areas within the communities studied by detailed engineering methods have base flood elevations established in A and V Zones. These are the elevations of the base (100-year) flood relative to the National Geodetic Vertical Datum of 1929. In coastal areas affected by wave action, base flood elevations are generally maximum at the open coast shoreline. These elevations generally decrease in a landward direction at a rate dependent on the presence of obstructions capable of dissipating the wave energy. Where possible, changes in base flood elevations have been shown in 1-foot increments on the FIRMs. However, where the scale did not permit, 2- or 3-foot increments were sometimes used. Base flood elevations shown in the wave action areas represent the average elevation within the zone. Current program regulations generally require that all new construction be elevated such that the first floor, including basement, is above the base flood elevation in A and V Zones.

3.3 Velocity Zones

The U.S. Army Corps of Engineers (Reference 16) has established the 3-foot breaking wave as the criterion for identifying coastal high hazard zones. This was based on a study of wave action effects on structures. This criterion has been adopted by the Federal Emergency Management Agency for the determination of V Zones. Because of the additional hazards associated with high-energy waves, the National Flood Insurance Program regulations require much more stringent flood plain management measures in these areas, such as elevating structures on piles or piers. In addition, insurance rates in V Zones are higher than those in A Zones with similar numerical designations.

The location of the V Zone is determined by the 3-foot breaking wave as discussed previously. The detailed analysis of wave heights performed in this study allowed a much more accurate location of the V Zone to be established. The V Zone generally extends inland to the point where the 100-year flood depth is insufficient to support a 3-foot breaking wave.

4.0 INSURANCE APPLICATION

The assignment of proper actuarial insurance rates requires that frequency and depth of flooding be estimated as accurately as possible. Because waves can add considerably to expected flood depths, it is important that insurance rates consider this additional hazard. The Federal Emergency Management Agency has developed a process to transform the data from this study into flood insurance criteria. This process includes the determination of Flood Hazard Factors and the designation of flood insurance zones.

4.1 Flood Hazard Factors

The Flood Hazard Factor (FHF) is the device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHF are used to set actuarial insurance premium rate tables.

The FHF is shown as a three-digit code that expresses the difference between the 10- and 100-year flood elevations to the nearest 0.5 foot. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, the FHF is computed to the nearest foot.

4.2 Flood Insurance Zones

After wave elevations for the 100-year storm surge were determined and mapped, the study areas were divided into zones, each having a specific flood potential and FHF. Each zone was assigned one of the following flood insurance zone designations:

Zone V11:	Special Flood Hazard Areas inundated by the 100-year flood, and that have additional hazards due to velocity (wave action); base flood elevations shown, and zones subdivided according to FHFs.
Zones A5, A7, and A9:	Special Flood Hazard Areas inundated by the 100-year flood, with base flood elevations determined and zone designations assigned according to the FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood plain, including areas that are protected from the 100- and 500-year floods by dike, levee, or other water control structure; and areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot, or where the contributing drainage area is less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas not subject to flooding by the 500-year flood. Zone C is not subdivided.

Table 2, "Flood Insurance Zone Data," summarizes the FHFs, flood insurance zones, and base flood elevations for each flooding source in the study area.

Table 2. Flood Insurance Zone Data

Flooding Source	Stillwater Elevation 10-Year	Stillwater Elevation 100-Year	FHF	Zone	Base Flood Elevation (Feet NGVD)*
Atlantic Ocean					
Open Coast	4.7	8.3	055	V11	10 to 13
			045	A9	8 to 10
Indian River					
North of Melbourne Causeway	4.5	6.0	025	A5	6 to 8
South of Melbourne Causeway	4.5	7.0	035	A7	7 to 9

*Due to map scale limitations, base flood elevations shown on the FIRM may represent average elevations for the zones depicted.

4.3 Flood Insurance Rate Map

After flood insurance zones were established for the study area, the FIRM for Indialantic was revised to incorporate the new zone information and revised zone boundaries. This map (Exhibit 1) contains the official delineation of flood insurance zones and base flood elevations.

In preparing the revised FIRM, updated topographic information was used to revise the Atlantic coastline and some zone boundaries in areas not affected by the wave height analysis. Corporate limits and cultural features were revised using a current community map (Reference 17).

5.0 OTHER STUDIES

The Flood Insurance Rate Maps for the adjacent Town of Melbourne Beach and the unincorporated areas of Brevard County are being revised concurrently with the Town of Indialantic to include wave height analysis. The revised studies for Melbourne Beach and Brevard County will be in agreement with this study.

6.0 REFERENCES

1. National Academy of Sciences, Methodology for Calculating Wave Action Effects Associated With Storm Surges, 1977

2. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Rate Map, Town of Indialantic, Florida, Scale 1:12,000, May 1976

3. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Technical Memorandum NWS TDL 52, SPLASH; (Special Program to List Amplitudes of Surges from Hurricanes): Part I, Landfall Storms, C. P. Jelesnianski, Silver Spring, Maryland, 1972

4. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Technical Memorandum NWS TDL 52, SPLASH; Part II, General Track and Variant Storm Conditions, C. P. Jelesnianski, Silver Spring, Maryland, 1974

5. U.S. Army Corps of Engineers, House Document No. 352, 90th Congress, 2nd Session, July 8, 1968

6. Brevard County, Florida, Board of County Commissioners, Basic Utilities Study, prepared by Ralph M. Parsons Company in Collaboration with Brevard County Planning Department, January 1969

7. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Personal Communication Between John F. Miller and Tom Hansen, U.S. Army Corps of Engineers, Jacksonville District, July 1977

8. U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 5 feet: Melbourne East, Florida (1949), Photorevised (1970)

9. Florida Department of Natural Resources, Bureau of Beaches and Shores, Brevard County Coastal Construction Control Line, Preliminary, Scale 1:1200, Contour Interval 2 feet, Photographed 1980

10. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, Storm Evacuation Map T-15077, Scale 1:62,500, Contour Interval 5 feet: Melbourne, Florida (1977)

11. Florida Department of Natural Resources, Bureau of Beaches and Shores, Brevard County Beach Profiles, Scale 1:600, 1972

12. U.S. Army Corps of Engineers, Jacksonville District, Plans for Construction of Beach Erosion Control Project, Brevard County, Florida, Beach Restoration and Advance Renourishment, Indialantic to Melbourne Beach, September 1978

13. Federal Emergency Management Agency, Stereoscopic Aerial Photography of Brevard County, Florida, Scale 1:12,000, 1981

14. Florida Department of Transportation, Stereoscopic Aerial Photography of Brevard County, Florida, Scale 1:12,000, 1980

15. Federal Emergency Management Agency, Users Manual for Wave Height Analysis, Revised February 1981

16. U.S. Army Corps of Engineers, Galveston District, Guidelines for Identifying Coastal High Hazard Zones, June 1975

17. Town of Indialantic, Florida, Indialantic Zoning Map, Scale 1:5470, April 1981